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RAPTOR RESEARCH

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THE PEREGRINE FALCON (*Falco peregrinus macropus*) Swainson IN SOUTHEASTERN QUEENSLAND

G. V. CZECHURA

ABSTRACT - Most studies of Peregrine Falcon (*Falco peregrinus*) biology have been conducted in Europe and North America (Hickey and Anderson 1969; Ratcliffe 1980; Cade 1982). Information concerning southern hemisphere Peregrines is restricted to the studies of Clunie (1972, 1976) on Fiji, reviews by Cade (1969), Brown (1970) and Steyn (1982) of African populations, while Chaffer (1944), Jones and Bren (1978), Norris et al. (1977), Olsen and Olsen (1979), Olsen et al. (1979), Olsen (1982), Pruett-Jones et al. (1981 a, b), Walsh (1978) and White et al. (1981) provide important contributions for Australia.

Declines in some nothern hemisphere populations due to the effects of pesticides (Hickey 1969; Bijleveld 1974; Newton 1979; Ratcliffe 1980; Cade 1982) have served to focus considerable attention on the distribution and dynamics of regional Peregrine Falcon (*Falco peregrinus*) populations. Concern has been expressed about the potential affects of pesticides on populations of this falcon within Australia (Olsen and Olsen 1979, 1981; Pruett-Jones et al. 1981b). Existing studies on the status of the peregrine within Australia have been conducted in the southeastern corner of the continent (Olsen and Olsen in press) and little is known of the status of northern and western populations. The following reviews the present state of knowledge of the peregrine in southeast Queensland. A more detailed, long-term study is underway.

MATERIALS AND METHODS

Information for this review was obtained from Queensland Museum records, literature, and previously unpublished observatios of both myself (1968 to present) and others. Geographic units referred to as southeastern Queensland and Moreton and Wide Bay — Burnett region follow Roberts (1979) and Mather (1976), respectively. Note that a bias toward the Moreton region exists - reflecting distribution of observers. Sufficient information is available for the presentation of a broad outline of distribution, breeding, hunting and conservation problems of peregrines over southeastern Queensland as a whole. Vegetation terminology follows Groves (1981).

DISTRIBUTION

Peregrine Falcons have been recorded over much of southeastern Queensland (Fig. 1; Table 1). In addition, they have been recorded in the immediate vicinity of the regional boundary (Broadbent 1889; Barnard and Barnard 1925; Longmore 1978; Passmore 1982). Vegetation type appears to exert little or no influence on the overall distribution here, as closed-forests, open-forests, woodlands, wetlands and agricultural areas are all frequented by falcons. For example, Dwyer et al. (1979) recorded peregrines from 8 of 12 habitat types found across Cooloola. The vegetation types represented here included vine forest, various forms of open forest and woodland as well as heath, herb and sedgeland. Wide occupation of vegetation types has been noted also in the Rockhampton area to the north (Longmore 1978).

Vernon (1976) and Roberts (1979) both note that peregrines favour mountainous areas with extensive cliffs and rocky outcrops. Examination of records used to construct Fig. 1 indicates that this is essentially correct with some modification. Certainly peregrines are well represented in mountainous areas as they have been seen on 11 of the 14 major mountain systems. However, they are also frequently observed in coastal districts where they may be locally abundant (Cooloola; Roberts and Ingram 1976). Examination of inland localities where peregrines are regularly encountered indicates an association with cliffs, gorges, and outcrops. Similarly, coastal records involve areas where eroded high dunes/coastal cliffs (Fraser, Moreton and North Stradbroke Islands), subcoastal highlands (MacPherson Range-Gold Coast) or isolated peaks (Mt. Cooroy-Peregian, Pumicestone Passage - Glasshouse Mountains) are found nearby.

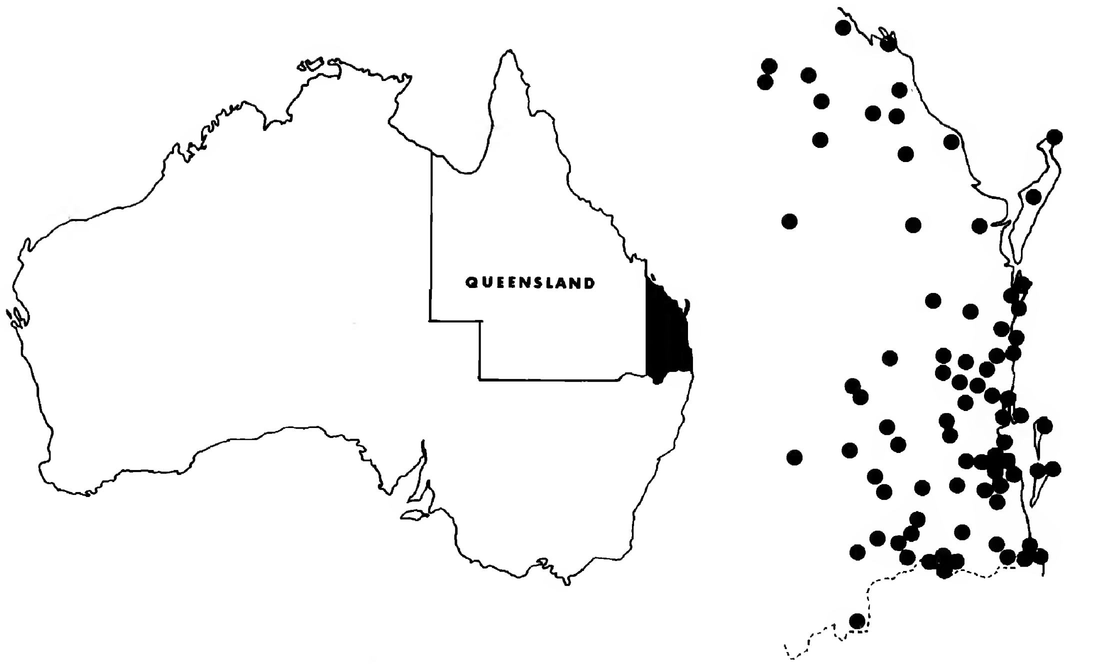

Figure 1. Distribution of *Falco peregrinus macropus* in southeastern Queensland based on both published and unpublished sightings.

BREEDING, DENSITY AND MOVEMENTS

Twenty-four active eyries (eggs and/or adults plus young present) are known from southeastern Queensland. In addition, several areas containing suspected eyries have yet to be examined and 1 eyrie previously known to be active was inactive. Most eyries were located within major range systems although 6 outlying sites are known. With the exception of 1 eyrie located on a high coastal foredune, vertical or subvertical rock faces along exposed cliffs or along gorges were utilized. Rock faces were variously composed of granite, trachyte, basalt or sandstone. The dune nest was situated on exposed sandrock-fossil hardpan. Individual eyries were placed on ledges, crevices or shallow caves (Fig. 2 A,B) between 30-270 m above ground level. The surrounding vegetation was either subtropical rainforest, open-forest or woodland.

Most eyries appeared to have been active for some time. One located within the northern Moreton region was active since the early 1940's, although peregrine records within this area indicate at least 50 yr occupation of the site. Activity associated with another Moreton region eyries indicates that it has been active for about 60 yr. The earliest records available for the southern Moreton region are from the early 1940's, and mid-1950's for the western Moreton region. Only very recent records are available for the Wide Bay-Burnett region.

Observations made wihin the northern Moreton region suggest that breeding starts mid-August or early September. Beruldsen (1980) records a nesting season of "July to October, sometimes November in the south, and April to June in the north". The earliest known egg-laying occurred in late July (1980) and the latest early November (1968). The latter cases appears somewhat anomalous and may represent either a late breeding or a replacement clutch. Display was noted during October and 2 fledglings were present during December. Little activity had been detected during September of that year. Pre-egg-laying display flights were typical of those used by peregrines elswhere and consists of mixtures of components such as High-circling, Figure-of-eight, Flight-rolling and Z-flight (Cramp and Simmons 1980;

Table 1. Summary of available published sightings of Peregrine Falcons in Southeastern Queensland.

LOCALITY	SOURCE
Callide Dam	Zillman 1974
Sandy Cape	Makin 1968
Fraser Island	Vernon and Barry 1972
Mt. Walsh	Frauca 1970
Maryborough	Anon. 1972, Jones 1981
Auburn River	*Darling Downs Naturalist* Dec. 1978:43*
Cooloola	Roderick 1975, Roberts and Ingram 1976; Dwyer et al. 1977
Teewah Creek	Ingram 1972
Noosa Heads	Wheeler 1959 (probable)
Jimna	Q.O.S. July 1978:2*
Kilcoy Shire	McEvoy et al. 1979
Blackall Range	Czechura in press
Maleny	Czechura 1970, Q.O.S. Jan. 1975:2
Conondale Range	Roberts 1977; Czechura in press
Glasshouse Mountains	Jack 1941; Fien 1966; MacArthur 1978
Pumicestone Passage	Mayo 1934; MacArthur 1978
Redcliffe	Q.O.S. May 1974:3
Crows Nest	Q.O.S. Oct. 1977:3
D'Aguilar Range	Illidge 1923; Vernon 1976
Pinkenba	Q.O.S. Nov. 1982:4
Lytton	Q.O.S. Nov. 1982:2
Bardon	a.S. May 1974:3
Stones Corner	Q.O.S. Nov. 1982:2
Murphy's Creek	Lord 1956
Pt. Lookout	Q.O.S. May 1977:4
North Stradbroke Is.	Vernon and Martin 1975
Cecil Plains	Q.O.S. June 1979:2
Cooper's Plains	Q.O.S. March 1976:3
Redwood Park	Q.O.S. July 1978:3
Cunningham's Gap	Vernon 1976
Dalrymple Ck.	Q.O.S. June 1977:2
Tweed R. District	Keast 1944
Warwick district	Kirkpatrick 1967
Emuvale	Q.O.S. Sept. 1977:2
Stanthorpe	Passmore 1982
Lamington N.P.	Robertson 1948
Binna Burra	Wheeler 1973; Q.O.S. July 1979:4

* Newsletters are cited in table only. 'Q.O.S.' refers to Queensland Ornithological Society Newsletter.

Monneret 1974; Ratcliffe 1980). In addition, a flight termed herein the V-flight, has been observed in which a circling or flying peregrine suddenly stoops with wings closed, terminates the stoop by spreading its wings and regains altitude using a combination of momentum and flapping flight (Fig. 3). The speed at which the stoop is terminated and altitude regained often leaves the impression of a stoop followed by a 'bounce'. The V-flight usually followed a period of High-circling, linear flight or undirected activity. Several flights may be conducted in quick succession. All display flights were

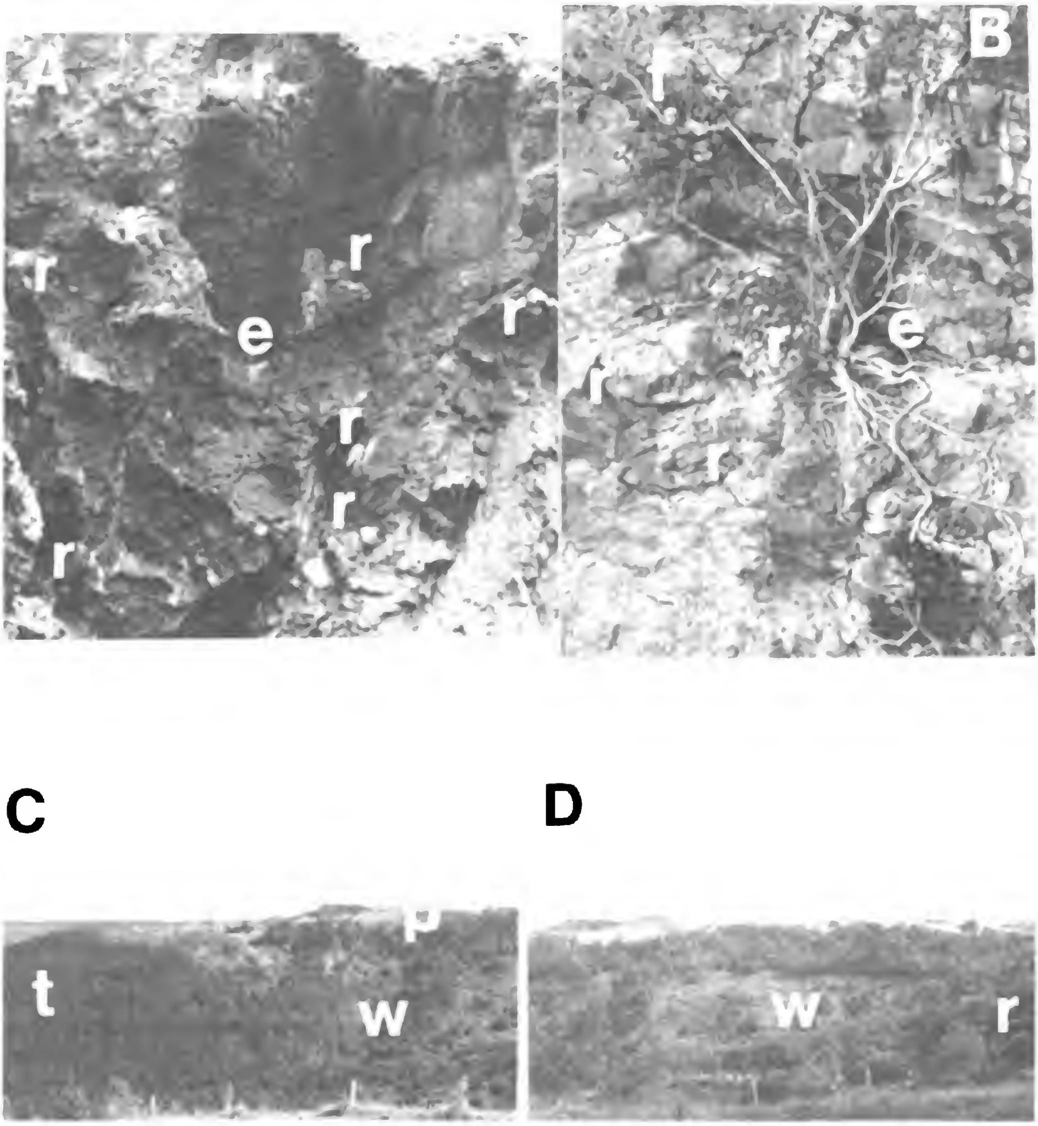

Figure 2: A. Ledge eyrie (e), eastern Moreton region; adjacent roosts (r) are also indicated. B. Cave eyrie (2), eastern Moreton region; perched peregrine (1) and adjacent roosts are indicated. The location of this eyrie is shown by its entrance. C-D. Peregrine hunting area (approx. 4 km SW Maleny). This area has been regularly used since 1970. Note different vegetation types present (r-rainforest, t-tall open-forest, p-pasture, w-regrowth).

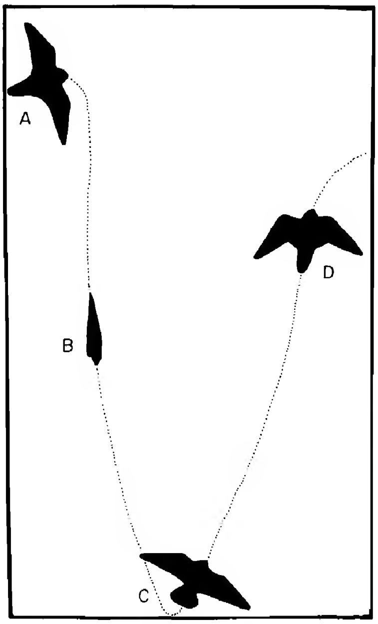

Figure 3. The 'V-flight' display. The display commences (A) from earlier circling or similar activity. The falcon abruptly stoops with wings closed (B), terminates the flight (C) by spreading the wings and regains altitude (D) using momentum and later flapping flight.

accompanied by much vocalization. Copulation usually occurred late during the display period and on areas surrounding the nest (ledges, projections of the cliff-face or adjacent trees).

Little information is available concerning clutch size. P. Olsen (pers. comm.) has examined 3 clutches (1 questionably from sotheastern Queensland). All consisted of 3 eggs. Indirect evidence, such as the number of fledglings at active eyries, suggests that a clutch size of 3 is usual (G. Geruldsen pers. comm.; pers. obs.). Typically 2 young fledge (Table 2). The maximum number of fledglings observed at a number of sites is 3 (pers. obs.; P. Slater pers. comm.; D. Evans pers. comm.,) suggsting either high productivity or occasional larger clutches. Olsen and Olsen (1979) record a mean clutch size for Queensland peregrines of 2.5 pre-1947 and 3.1 post-1947. Savidge (in Mathews 1916) records cliff-face nesting in the Clarence River district of northeastern New South Wales and collected the following successive clutches from 1 pair of falcons; 16 August, 3 eggs; 13 September, 3 eggs; 14 October, 2 eggs.

Data from southeastern Queensland appear consistent with similar data from southeastern Australia. The presumed clutch size of 3 in southeastern Queensland compares favourably with both the State means (above) and the combined means for New South Wales, Victoria, South Australia and Tasmania (pre-1947, 3.0; post-1947, 2.7; data from Olsen and Olsen 1979). Olsen (1982) did not find any significant correlation between clutch size and latitude, longitude or temperature. Similarly, comparison of the mean numbers of fledglings of the 2 Moreton region eyries (2.13, 2.25; Table 2) indicates that these values are within the range for numbers of young at successful eyries in New South Wales (2.2), Victoria (2.1), South Australia (2.2) and Tasmania (2.5) (data from Pruett-Jones et al. 1981; Olsen and Olsen in press).

Pending the completion of survey work currently in progress, only approximate values of peregrine density over the entire region are available. Estimates, based on known pairs in the Moreton region, indicate a density of about 1 pair/2600 km^2, while taking suspected pairs into consideration a value of 1 pair/1500 km^2 is suggested. These values com-

Table 2: Fledgling number at 2 adjacent northern Moreton Region Eyries 1968 - 1982.

	Numbers of Fledglings Observed	
Year	Eyrie A	Eyrie B
1968	2	*
1969	2	*
1970	3	*
1972	3	*
1976	2	*
1977	1	*
1979	2	2
1980	*	3
1981	*	2
1982	2	2
Mean	2.13	2.25

* - No data available

pare with a density of 1 pair/100 km^2 for one area under study. Distances between neighboring eyries range from 4.8 - 65 km (mean 40.9, N = 221 km). The above density values are tentative. This uncertainty reflects the difficulty in locating alternate nesting sites (e.g., stick nests) in dense forest (rainforest, tall open-forest) and poor accessibility to some highland areas supporting suitable cliff faces. The current estimates indicate a nesting density well below that of Victoria (1 pair/600 - 800 km^2, White et al. 1981) and slightly higher than Tasmania (Olsen and Olsen in press).

Storr (1983) considers *F. p. macropus* to be nomadic and evidently migratory over much of Queensland. He noted that most records involved the period April-October. Monthly observations at several more accessible Moreton region eyries strongly suggested that breeding birds are relatively sedentary with roosts being maintained around the eyrie outside the breeding season. Observations made by Jones and Bren (1978) and Olsen and Olsen (in press) indicate the same in southeastern Australia. Hunting is less frequent but conducted over much the same area as used during the breeding season. In general, it seems that the apparent nomadism of peregrines may be attributable to the inconsicuousness of adults around eyries outside the breeding season and movements of immature birds. Locally high densities have been reported (Elks *in* Roberts and

Table 3. Prey recorded for the Peregrine Falcon (*Falco peregrinus macropus*) in Southeastern Queensland.

Prey Items	Source
Insects	
Orthoptera	P. Slater pers. comm.
Odonata	Pers. obs.
Birds	
Prion (*Pachyptila* sp.	C. Corben pers. comm.
Cormorants (*Phalacrocorax* spp.)	Mayo 1934
Sacred Ibis (*Threskiornis aethiopicus*)	Czechura 1971, pers. obs.
Black Duck (*Anas superciliosa*)	R. Lutkins pers. comm.
Grey Teal (*Anas gibberifrons*)	R. Lutkins pers. comm.
Australian Kestrel (*Falco cenchroides*)	B. Cowell and G. Czechura obs.[1]
Stubble Quail (*Coturnix novaezelandiae*)	Czechura 1979
Brown Quail (*Coturnix australis*)	Czechura 1979
Red-kneed Dotterel (*Erythrogonys cinctus*)	G. Roberts pers. comm.
Red-necked Stint (*Calidris ruficollis*)	C. Corben and G. Czechura obs.
Feral Pigeon (*Columba liva*)	C. Corben pers. comm., D. Evans pers. comm.
Crested Pigeon (*Ocyphaps lophotes*)	P. Veerman pers. comm.
Bar-shouldered Dove (*Geopelia humeralis*)	pers. obs.
Rainbow Lorikeet (*Trichoglossus haematodus*)	pers. obs., D. Evans pers comm., C. Corben pers. comm.
Scaly-breasted Lorrikeet (*Trichoglossus chlorolepidotus*)	pers. obs.[1], D. Evans pers. comm.
Pale-headed Rosella (*Platycercus adscitus*)	Prey remains at eyrie
White-throated Needle-tail (*Hirundapus caudacutus*)	G. & R. Czechura obs.[1]
Black-faced Cuckoo-shrike (*Coracina novaehollandiae*)	pers. obs.
Lewin Honeyeater (*Meliphaga lewinii*)	pers. obs.[1]
Noisy Friar-bird (*Philemon corniculatus*)	pers. obs.[1]
Noisy Miner (*Manorina melanocephala*)	pers. obs.[1]
Yellow-faced Honeyeater (*Lichenostomus chrysops*)	pers. obs.
Common Starling (*Sturnus vulgaris*)	pers. obs.[1]

[1] Includes observations made at eyrie during breeding season.

Ingram 1976) but as with most reports, it is not known if these involve adults or immatures. Immatures once independent, rarely remain in the vicinity of the eyrie for longer than 4 - 8 weeks approximately, although lone birds may take up residence in areas rarely frequented by the adults (pers. obs.). Otherwise little is known of movements or fate of the majority of immature birds.

Hunting and Prey - Peregrines were observed hunting in a variety of habitat and landscape types. Some regularly hunted over both very open (mudflats, waterways, pastureland) and densely vegetated (rainforest, tall open-forest, heathland) areas (Fig. 2 C, D). Presumably, hunting areas were determined by the location of nesting sites.

Prior to the advent of European settlement in southeastern Queensland, peregrines were largely assocated with forested habitats. Rainforest vegetation was more extensive in coastal and subcoastal districts than at present (Illidge 1925; Francis 1970). Indeed, Cade (1982) noted that Australian populations of *F. peregrinus* show modifications of the feet and beak typical of "forest" races of the peregrine, *F. p. peregrinator* (India), *F. p. ernesti* (New Guinea) and *F. p. nesiotes* (Figi) and the two large, forest-dwelling species, Orange-breasted Falcon (*Falco deiroleucus*) and New Zealand Falcon (*Falco novaeseelandiae*). Similarly, Pruett-Jones et al. (1981a) have commented on modifications of hunting techniques for dense woodland and forests in Victoria.

Birds were the chief prey (Table 3). Brief descriptions of some hunting flights are given by Mayo (1934) and Czechura (1970, 1971). Comparison of published and unpublished observations with the descriptions of Treleaven (1977), Ratcliffe (1980) and Cade (1982) indicate most hunting consists of a period of "still hunting" or "waiting on" followed by the traditional stoop or direct pursuit. "Still hunting" (Fig. 4-1A) involves the falcon launching an attack from a perch, such as an emergent tree in rainforest, on passing birds. On leaving the perch, the peregrine either gained altitude and then stooped onto the prey, made a level dash towards it (Mayo 1934; Czechura 1971) or stooped directly onto it. "Waiting On" (Fig. 4-1B) involves the raptor initially spending some time circling and/or engaged in active flight before stooping. The actual stoop (Fig. 4-2B) is usually conducted with wings closed or partly closed in a rather shallow angle of attack. The final stages of the stoop may result in complex aerial manoeuvres as prey attempts to evade the falcon (Fig. 4-1B). Once the prey is struck by the peregrine, a loop may be performed to retrieve the body (Fig. 4-2B) or the bird may be simply seized and carried. Direct pursuit usually culminates in the peregrine seizing the prey.

Under special circumstances other hunting techniques were employed. "Solitary flushing" may be employed against ground-dwelling quail (Czechura 1979). The peregrine will make rapid, low-level passes above the vegetation sheltering the quail. If quail flush, direct pursuit will result. Peregrines, at other times, will "hawk" flying insects by leisurely circling amongst the insects and snatching them out of the air or snatch birds sheltering on the ground as they pass overhead, e.g., waders on mudflats.

It is difficult to determine hunting efficiency of peregrines. On many occasions a falcon will indulge in numerous attacks for up to an hour before a successful kill is made. Many attacks, however, do not appear to be pressed with determination (low intensity attacks, Treleaven 1977) e.g., the falcon breaks off early, stoops are short and relatively slow. During such times, and sometimes after feeding, "playful" attacks are made on large birds such as ibis (*Threskiornis* spp.) and Torrsian Crow (*Corvus orru*). Under the circumstances, lone crows or ibises are stooped on, with the peregrine often looping around the intended victim and then flying away. Similarly, flocks may be attacked with the apparent objective of breaking them up into smaller units. Bouts of such playful behaviour are interspersed with periods of soaring, slow flying and perching. Attacks on flocks of birds are usually unsuccessful if the flocks maintain their structure (Fig. 4-1C). Lone birds that attempt to leave the flock often are very quickly captured (Fig. 4-2C). Fruit pigeons and lorrikeets will often attempt to out-manoeuvre the falcon and seek shelter in the canopy of nearby trees by perching or flying through them. Frith (1942) reported such behaviour among fruit pigeons in northern New South Wales but notes one case where the pursuing peregrine pressed its attack below the forest canopy. While successful attacks have been observed on lorikeets (*Trichoglossus* spp.) and honeyeaters, no successful attacks have been reported on either Topnot Pigeon (*Lopholaimus antarcticus*) or White-headed Pigeon (*Columba leucomela*) flocks.

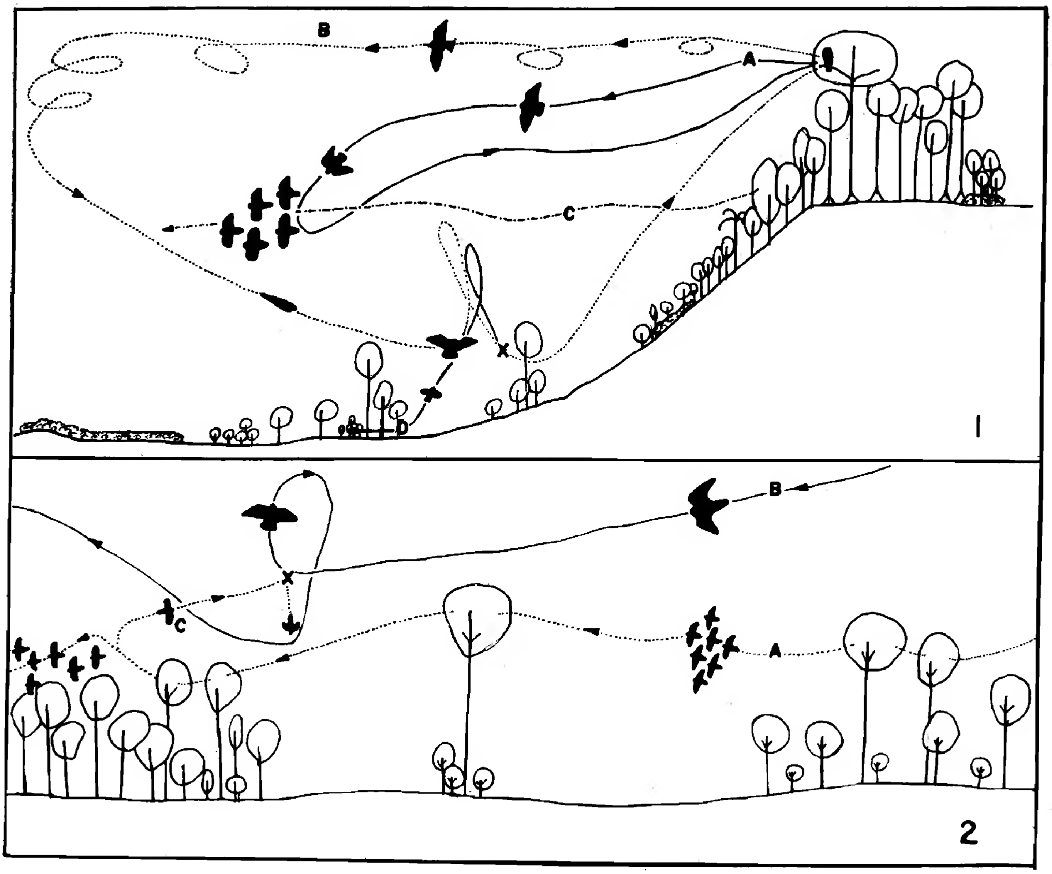

Figure 4. Peregrine Falcon (*Falco peregrinus*) hunting behavior.

4.1 Hunting over rainforest and pasture-regrowth area near Maleny (profile taken from transect across part of the hunting area shown in Plate 1 C-D). A. Unsuccessful (?low intensity) attack on a flock of Topknot Pigeons (flight path C) leaving rainforest canopy. The adult female peregrine was perched in an emergent *Ficus* sp. and returned after this attack. B. Successful attack on an unidentified honey-eater (D) after a period of soaring. The honeyeater attempted to climb, then dive away from the falcon prior to its capture (x). Plucking and feeding was conducted on the perch atop the emergent *Ficus* sp. This attack was conducted approximately 15 mins after attack A.

4.2 Successful hunt over woodland - pasture - low riverine rainforest near Woodford. A. Feeding flock of lorikeets were attacked by an adult female peregrine (B) after leaving the central tree. The flock, except one bird (C) fled through the canopy of adjacent trees. Bird C was struck by the falcon, caught after a rapid loop, then carried.

Although very little is known of hunting and prey species of peregrines in the region during early settlement, observations made by Savidge (*in* Matthews 1916) in the Clarence River district of northeastern New South Wales suggest little change has taken place. Savidge records the followng prey, Black Duck (*Anas superciliosa*), Rainbow Lorikeet (*Trichoglossus haematodus*), Pale-headed Rosella (*Platycercus abscitus*), Australian Magpie-lark (*Grallina cyanoleuca*) Feral Pigeon (*Columba livia*) and Feral Chicken (*Gallus gallus*). All but *G. cyanoleuca* and *G. gallus* have been recorded among prey from southeastern Queensland (Table 3).

Interactions with Other Raptors - Interaction between the Australian Hobbie (*Falco longipennis*) and peregrines occur in many areas with the exception of heavily timbered and some upland areas (Czechura in press). Both falcons may be found hunting in the same areas on occasion (e.g., Woodford, Caboolture), especially when lorikeets are abundant. At these times peregrines largely hunt the Rainbow Lorikeet (*Trichoglossus haematodus*) and Scaly-breasted Lorikeet (*Trichoglossus chlorolepidotus*), while Australian hobbies hunt *T. chlorolepidotus* and the smaller Little Lorikeet (*Glossopsitta pusilla*). The Brown Falcon (*Falco berigora*) occurs with peregrines in many areas with the exception of densely timbered country. Interactions between Brown and Peregrine Falcons appear to be mildly aggressive. Brown Falcons will often leave hunting areas after the appearance of peregrines. At other times peregrines may make 1 or 2 casual stoops at flying Brown Falcons or Brown Falcons may stoop at perched peregrines. The Australian Kestrel (*Falco cenchroides*) comes into contact with peregrines in the same habitats as Brown Falcons. Kestrels readily mob perched peregrines, while Czechura (1970) has reported a possible 'play' encounter. On one occasion a kestrel was among prey brought to an eyrie (Table 3).

Peregrines have been observed mobbing the Whistling Kite (*Haliastur sphenurus*) on 2 occasions along Pumicestone Passage. Both of these involved the same immature female peregrine. Otherwise observations are restricted to encounters near eyries. On several occasions the Wedge-tailed Eagle (*Aquila audax*) and once a Grey Goshawk (*Accipiter novaehollandiae*) were mobbed by one or both falcons as they approached eyries.

Mortality and Conservation - Little is known of natural mortality among peregrines in southeastern Queensland, although one was found dead after a hailstorm in the Brisbane area (Q.M. ornithological records). The most significant cause of mortality appears to be human persecution. Pigeon fanciers have destroyed adults and interfered with eyries in the eastern Moreton region. Some falcons certainly fall victim to general persecution of raptors. Disturbance at eyries also results from sightseers, bushwackers and illegal egg-collectors.

The nature and extent of pesticide effects within the region are poorly known. Olsen and Olsen (1979) found greater than 20% eggshell thinning attributable to D.D.T. in clutches from southeastern Queensland; this compares with a State mean of 3.6%. Shell thinning of 15-20% is critical - affected eggs would not be expected to withstand incubation (Newton 1979; Ratcliffe 1980). No peregrines have come to the Small Animal Clinic, Department of Veterinary Science, University of Queensland, suffering from pesticide poisoning (W. Rooke pers. comm.), but the Clinic has received other diurnal raptors suffering from pesticide poisoning.

Some recent developments in the patterns of pesticide use in southeastern Queensland are of concern. *Heliothis* moths are serious crop pests (Broadley 1977) and recent failure of a number of synthetic pyrethrins used in their control has led to renewed use of organochlorines in a number of areas, while serious outbreaks of armyworms (*Pseudaletia* spp., *Spodoptera* sp.; Broadley 1978, 1979) in southern subcoastal pasturelands have necessitated use of pesticides (particularly via aerial application), where their usage has traditionally been of a low level.

Although a number of eyries are within the existing national park-reserve system, there are no specific conservation/management programmes in operation. The species is protected under the provisions of the Fauna Conservation Act of 1974.

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Attention RRF Members Past and Present!! The Raptor Research Foundation, Inc., is approaching its 20th Anniversary. In honor of this memorable occasion, I am compiling a twenty-year history of the Foundation to be presented in Sacramento at the 1985 annual meeting. In addition, plans are to compose a monograph detailing the Foundation's history from beginning to present. I request the assistance of you, the membership, both past and present, in accomplishing this task. Please contact me if you have any pertinent information in your files, such as photographs, correspondence, etc., that you would be willing to loan to me. All such material will be acknowledged in publications, of course, and I will make copies of the materials for my use and return the originals immediately. If you have anything you wish to contribute, please contact me as follows: Jimmie R. Parrish, Department of Zoology, 159 WIDB, Brigham Young University, Provo, Utah 84602, USA.

SPRING AND FALL MIGRATIONS OF PEREGRINE FALCONS IN CENTRAL ALBERTA, 1979-1983, WITH COMPARISONS TO 1969-1978

Dick Dekker

Abstract - In central Alberta, 1979-1983, 339 sightings of migrating Peregrine Falcons (*Falco peregrinus*) were recorded between 15 April and 31 May. Mean sightings per hour afield were 0.23 for the entire period and 0.29 for the main migration period 4-23 May, respectively 11 and 19% lower than for 1947-1978. Mean early dates, mid-dates and mean late dates for adults were respectively 6, 7 and 2 days in advance of immatures, and nearly identical to 1969-1978. Fall sightings were similarly scarce as in 1969-1978, totalled 24, and occurred from 17 September to 3 October. In fall, the ratio of adults to immatures was roughly 1:3 and in spring 1:1. The success rate of 191 hunting attempts was 9.4%.

Since the 1950's, the Peregrine Falcon (*Falco peregrinus*) has suffered serious population declines in North America (Hickey 1969). As a breeding bird it was extirpated in southern and central Alberta by the early 1970's (Fyfe et al. 1976), although captivity-raised and released falcons nested in Edmonton and Calgary in 1982 and 1983 (G. Erickson, Alberta Fish and Wildlife Division, pers. comm.). In spring and fall, northern peregrines migrate through central Alberta (Dekker 1979). Field surveys along the Atlantic and Texas coasts have recently shown substantial increases in the number of peregrines sighted during fall migrations (F.P. Ward, pers. comm.). This paper presents data on the characteristics of migrating peregrines in central Alberta from 1979 to 1983. Pooled data for these 5 yrs can be juxtaposed to data from 1969 to 1978 when I did similar field studies (Dekker 1979), although data for 1969-1973 are incomplete and based on less expertise. The most recent 10 yrs allow valid comparisons of number of sightings/h, age ratios and timing of migrations.

Study Area and Methods

The study area was a crescent-shaped strip of grainfields and open pastures, roughly 10x2 km in size, bordered by Beaverhill Lake, that attracted numerous waterfowl and shorebirds in migration. In searching for peregrines no set procedures were followed, although methods were similar to those of 1969-1978. Each day afield I hiked 5-25 km, frequently pausing to scan through 10x50 binoculars. I often sat in a parked car and used a 20-40X telescope as well as binoculars. Many resting peregrines sitting on fence posts or on the ground were watched until they left of their own accord. Flying peregrines were observed for as long as they remained visible. Alarm behaviour of prey species often alerted me to the arrival of peregrines. The study area was visited from early March to early December. Pooled for 5 yrs, field days totalled 167 and 79 respectively during 15 April - 31 May and 1 September-15 October. Field days lasted 3-17 and averaged 9 h within varying time frames. About 85% of peregrines sighted in spring were positively identified; distant large falcons that I could not identify were assumed to be peregrines unless I suspected them of being Prairie Falcons (*Falco mexicanus*), that are occasionally seen in the study area in spring (Dekker 1982). During fall, when peregrines are uncommon in the study area and both the Prairie Falcon and the Gyrfalcon (*Falco rusticolus*) occur (Dekker 1983), all sightings of unidentified large falcons were deleted. (For criteria used in field identification see Dekker 1977). I paid little attention to the problem of duplicate sightings other than to delete obvious ones. For 1969-1978 I tabulated maximum and minimum sightings that show a duplication rate of 2.4. This indicates the magnitude of the problem but is only an estimate. The so-called maximum numbers of 1969-1978 "include duplicate counts except the most obvious ones", (Dekker 1979:297) and correspond to sightings in this study. Data on hunting are for 1980-1983 only; 1979 observations were presented elsewhere (Dekker 1980). Methods in recording foraging behavior were the same as in 1969-1978. Observations were written down during or at the end of the day.

Results and Discussion

Numbers Sighted and Timing of Migrations - In spring, peregrines were seen from 20 April to 31 May (Fig. 1). Sightings pooled for 5 yrs ranged from 0 to 21/d and totalled 339 (Table 1). Mean numbers of sightings/h were 40-60% higher in morning and evening than between 1200H and 1500H (Table 2).

Earliest dates ranged from 20 to 30 April. Mean early dates for adults and immatures respectively, ranged from 20 April to 7 May and from 1 to 9 May. Early arriving falcons appeared to pass quickly. They often hunted over the still-frozen lake and rested on the ice far from shore. I suspect that all April sightings of unidentified falcons involved adults. That assumption would advance their mean early date to 25 April, 9 d ahead of immatures (Table 3). Mean late sightings of adults and immatures respectively, ranged from 17 to 27 and 19 to 31 May. Mean late dates and mean mid-dates (half of total sightings) were nearly equivalent to those of 1969-1978 (Table 3).

To check for the presence of summering falcons, the study area was visited about 4 times/month

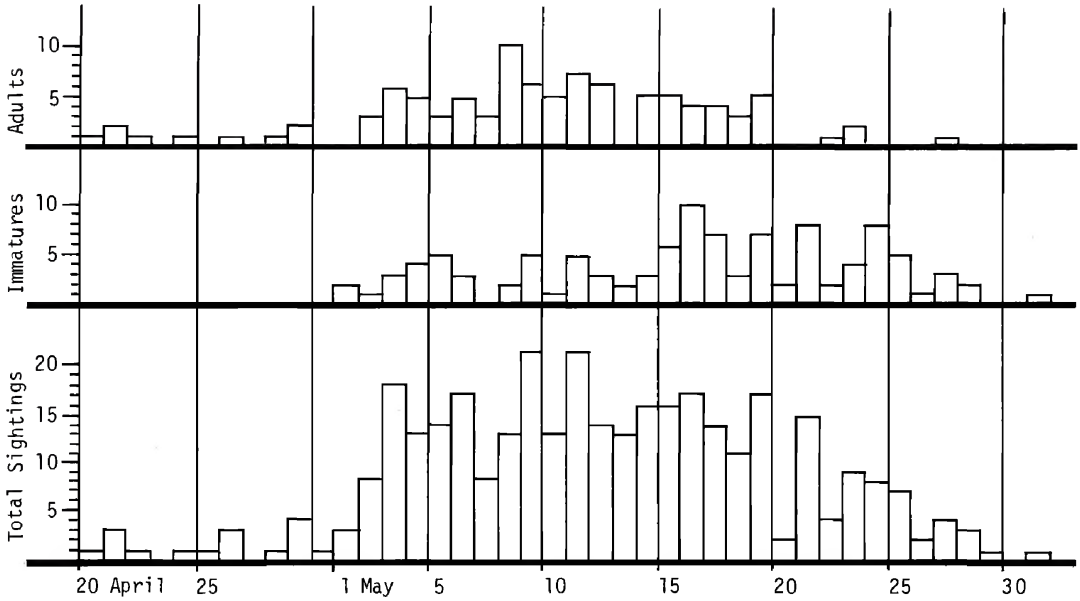

Figure 1. Peregrines sighted during spring migration in central Alberta. Total sightings include peregrines of unidentified age class.

(range 3-7) in June, July and August. One peregrine each was seen on 19 July 1980 and 2 June 1982. Both were immatures. The June sighting probably involved a late migrant, but the July bird may have originated from a captive-breeding program with releases in central and southern Alberta (G. Erickson, Alberta Fish and Wildlife Division, pers. comm.). I saw no evidence that captive-bred peregrines occurred in the study area during spring migration. Data for the autumn were similarly limited as in 1974-1978 and ranged from 17 September to 3 October.

Age and Sex Ratios - The proportion of adults and immatures in spring differed from 1974-1978 (Table 4). I attribute that difference to the following change in my criteria for identification. In 1969-1978 I differentiated the age groups mainly by dorsal coloration; adults are ashy-blue, immatures brownish. However, I have found that dorsal color is not always a reliable fieldmark as some adult peregrines look blackish-brown dorsally, resembling the spring immatures that are often light-chested (Dekker 1979). Since 1979, I have included all dorsally blackish falcons in the unidentified category unless I saw their ventral markings, barred in the adult, streaked in the immature. The more typically-colored adults are easily identified in flight under good conditions. The proportion of adults (29%) was remarkably close to that of 1974-1978 (28%) but differed from 1969-1973 (38%). The adult and immature percentages for fall differed from 1969-1973 and 1974-1978, but sample size was small (Table 4).

The smallest males are about two-thirds the size of the largest females (Godfrey 1966). However, I was unable to determine the sex of 54% of sightings. Under some conditions, especially when flying falcons interacted with other birds, their relative size could be assessed with confidence. Large peregrines outnumbered small ones by a factor of 3:1 in the adults and 9:1 in immatures. Although females outnumbered males also in 1969-1978, values differed substantially, probably reflecting the unreliability of basing sex ratios on sightings. Females outnumbered males by a factor of 3:1 or more in coastal migration surveys (Hunt et al. 1975; Ward and Berry 1972).

Behavior - I saw falcons attack prey species 254

Table 1. Days and hours afield, and peregrines sighted, 15 April - 31 May 1969-1983. (figures in brackets represent the main migration period 4-23 May, when respectively 79, 85 and 79% of pooled sightings occurred in 3 groups of 5 years).

YEAR	DAYS AFIELD	HOURS AFIELD	SIGHTINGS	MEAN SIGHTINGS/HR
1969	22(12)	-	20(9)	-
1970	25(16)	-	15(11)	-
1971	27(17)	-	33(27)	-
1972	25(16)	-	26(21)	-
1973	23(16)	-	41(39)	-
Sub-Totals	122(77)	-	135(107)	-
1974	26(16)	251(166)	46(43)	0.18(0.26)
1975	29(16)	284(171)	41(35)	0.14(0.20)
1976	30(17)	307(196)	66(53)	0.21(0.27)
1977	38(19)	378(216)	163(153)	0.43(0.71)
1978	34(19)	358(229)	90(64)	0.25(0.28)
Sub-Totals	157(87)	1570(978)	406(348)	0.26(0.36)
1979	31(16)	289(179)	57(46)	0.20(0.26)
1980	34(18)	323(194)	94(55)	0.29(0.28)
1981	34(19)	308(193)	67(59)	0.22(0.31)
1982	33(18)	276(172)	58(53)	0.21(0.31)
1983	35(19)	302(197)	63(56)	0.21(0.28)
Sub-Totals	167(90)	1498(035)	339(269)	0.23(0.29)

times. The success rate of 191 hunting attempts of which the outcome was known was 9.4%, not significantly different from the 7.7% reported for 1965-1979 (Dekker 1980). Prey captured included 9 ducks of 7 species and 9 shorebirds of 4 species.

In the first 2 h after daybreak, when I was rarely in the field (Table 2), I only once saw a falcon attack ducks, but I found falcons feeding on ducks 7 times. In one case the prey was a Gadwall (*Anas strepera*) I had seen killed by a falcon the previous evening at dusk. In the others, sunken eyes of ducks and amount of meat taken from the carcasses led me to suspect that they had been killed the previous evening, during the night or near dawn. On several occasions I saw peregrines attack ducks 0.5-1 h after sundown, and they hunted sandpipers or passerines very late in the evening. Crepuscular foraging activity of peregrines has been reported by several observers (Beebe 1960; Clunie 1976; Dekker 1980). Some falcons that I watched at nightfall stayed on posts until it was too dark to see them and they probably roosted there. Their locations were not only over water but also on open pasture. All roosting falcons (n=9) were gone next morning at dawn.

Most resting falcons that I watched in the morning from 1 h after sunrise remained inactive until 0900-1100 H when some began to hunt; others soared to great heights and sailed away in a northerly direction, apparently resuming migration. In 1969-1978, falcons under observation left the study area in late morning by soar and sail flight at great altitudes (Dekker 1979). Each spring, 1 or 2 recognizable peregrines stayed in the study area for

Table 2. Percent of total field time for 5 daily periods, 15 April-31 May (figures in brackets represent main migration period 4-23 May). Data pooled for periods of 5 years. Mean sightings per hour afield not available for 1974-1978 when the exact time of most sightings was not recorded.

	% of Total Hours Afield		Mean Sightings/Hr
Time Period	1974 - 1978	1979 - 1983	1979 - 1983
0500 - 0900	6.7 (7.7)	8.3 (10.5)	0.28 (0.33)
0900 - 1200	19.3 (21.6)	17.8 (19.1)	0.28 (0.36)
1200 - 1500	24.8 (24.3)	20.5 (20.5)	0.17 (0.21)
1500 - 1800	26.9 (24.1)	27.0 (23.7)	0.20 (0.26)
1800 - 2200	22.4 (22.3)	26.4 (26.2)	0.24 (0.31)
TOTALS	100 (100)	100 (100)	0.23 (0.29)

3-8 d, no doubt causing duplication of sightings.

Conclusions - Although mean numbers of sightings/h in spring were 11-19% lower in 1979-1983 than in the preceding 5 yrs, most yearly figures have remained similar, suggesting that no change has occurred in the size of the spring population migrating through central Alberta. An exceptional year was 1977 when sightings/h were 65-95% higher than the 5 yr mean (Table 1). The spring of 1977 was characterized by dry climatic conditions when peregrines and their prey concentrated on the lakeshore where they were readily located.

Why peregrines were much scarcer in fall than in spring in the study area is not clear. Perhaps some peregrine populations breeding in the northwest migrate in fall via a flight path east of Alberta to the Atlantic coast, but return in spring by a more direct

Table 3. Mean early dates, mid-dates (half of total sightings) and mean late dates for adult and immature peregrines sighted during spring migration in central Alberta. Data pooled for 3 groups of 5 years, 1969-1983. ("All sightings" include falcons of unidentified age).

	Mean Early Dates			Mid-Dates			Mean Late Dates		
Years	Adult	Immatures	All Sightings	Adult	Immatures	All Sightings	Adult	Immatures	All Sightings
1969-1973	28 April	3 May	29 April	8 May	15 May	13 May	19 May	25 May	25 May
1974-1978	25 April	7 May	24 April	7 May	14 May	12 May	19 May	25 May	25 May
1979-1983	28 April	4 May	25 April	9 May	16 May	11 May	22 May	24 May	25 May

Table 4. Age composition of peregrines in percent of total sightings during spring and fall. Data pooled for 3 groups of 5 years, 1969-1983.

YEARS	SIGHTINGS	% ADULT	% IMMATURE	% UNIDENTIFIED
Spring				
1969-1973	135	38	36	26
1974-1978	406	28	47	25
1979-1983	339	29	32	39
Sub-Totals	880	32	38	30
Fall				
1969-1973	10	50	30	20
1974-1978	17	6	65	29
1979-1983	24	21	58	21
Sub-Totals	51	26	51	23

route through the continent. Differentiation of spring and fall migration routes has been documented for some shorebird species (Godfrey 1966).

Early and late dates of fall and spring sightings in the study area were respectively 16 and 41 d apart in 1979-1983 and 24 and 45 d in 1969-1978. Why the spring passage lasts so much longer than the fall migration is not known. Perhaps spring migrant peregrines, especially subadults, linger in the study area attracted by the concentrations of migrating shorebirds, which are more numerous in May than at any time during fall.

Although the number of fall migrating peregrines was too small for comparisons, the number of sightings/d increased from 0.24 in 1969-1978 to 0.30 in 1979-1983, consistent with increases in sightings per unit effort during fall migrations along the Atlantic and Texas coasts (F.P. Ward, pers. comm.).

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WINTER HABITAT SELECTION OF DIURNAL RAPTORS IN CENTRAL UTAH

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Abstract - A total of 525 observations of 10 species was recorded during a winter roadside survey of raptors around Utah Lake, Utah Co., Utah. Six species; Red-tailed Hawk (*Buteo jamaicensis*), Rough-legged Hawk (*Buteo lagopus*), American Kestrel (*Falco sparverius*), Northern Harrier (*Circus cyaneus*), Golden Eagle (*Aquila chrysaetos*), and Bald Eagle (*Haliaeetus leucocephalus*); accounted for 493 (94%) of the observations. Red-tailed Hawks, Rough-legged Hawks and American Kestrels were found in greater than expected numbers in grassland habitat, Northern Harriers and Golden Eagles in sage/greasewood desert, and Bald Eagles in riparian/lakeshore habitat. Rough-legged Hawks predominantly used utility pole rather than tree perches; American Kestrels predominantly used wire perches; Red-tailed Hawks used tree and pole perches according to availability. All species, except American Kestrels, used areas away from centers of human activity more often than expected.

Ornithological literature contains relatively little information on the winter ecology of diurnal raptors (Newton 1979). Road surveys taken over several months can provide information on distribution, relative abundance and habitat use (Craighead and Craighead 1956; Bildstein 1978). This information may provide a basis for making land use decisions. Although many raptor road surveys have been conducted (Enderson 1965; Johnson and Enderson 1972; Craig 1978; Bauer 1982; Gessaman 1982), few have studied habitat or perch use in relation to availability, a prerequisite for making inferences concerning species preference or selection. Here, we conducted a road survey of wintering raptors and sampled the availability of general habitat types, specific perch types and proximity of centers of human activity along a 125 km census route. We then tested the (null) hypothesis that raptor use is in proportion to habitat availability. Where use of a particular habitat type was found to be significantly greater than expected, we infer selection or preference on the part of the species involved. Some argue that selection can only be demonstrated by detailed behavioral observations in which an active choice on the part of the animal is shown (see Morse 1980). We assume, however, that raptors are highly mobile organisms capable of moving from one habitat or perch type to another in a matter of minutes. Therefore, we infer an active choice on the part of the species if it occupies a particular habitat type significantly more often than could be expected by chance.

Study Area and Methods

A 125 km loop around Utah Lake, beginning near Provo and terminating near Lindon, defined the census route (Fig. 1). Average elevation of Utah Valley is 1371 m. Mean annual precipitation ranges between 30.4 and 40.6 cm. Daily mean temperature during the period December-March ranged from approx. -15°C to 10°C. Vegetation was a mosaic of agricultural lands (irrigated and dry), sagebrush (*Artemesia tridentata*) mixed with greasewood (*Sarcobatus vermiculatus*) desert, grassland/pasture, orchard, and riparian/lakeside woodland. Topography of the census strip was generally flat.

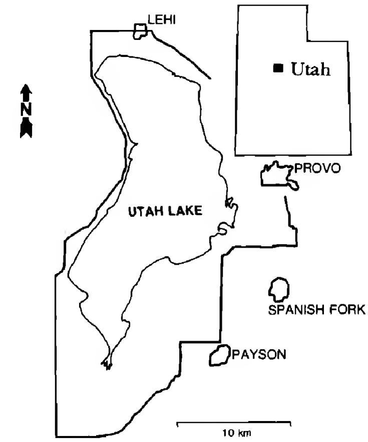

Figure 1. Map of census route, Utah County, Utah.

Twelve censuses totalling 42 h were conducted weekly from 8 January to 27 March 1983. Direction of travel along the census route was alternated each week. Roads on the east side of the lake were driven at speeds of 40 kph or less. Those on the west side, where there is little vegetation to impair vision and there are fewer potential raptor perch sites, were driven at speeds of 72 kph or less. Brief stops to identify birds and record data were sometimes made. Mean speed of travel per census was 36 kph. Mean time to complete a census was 3.45 h. The number of observers was usually 2, with 3 observers present on 2 occasions and a single observer present on 1 occasion.

Only those birds seen initially with the unaided eye were tallied. Binoculars and a 20x spotting scope were used to aid identification. For each sighting we recorded location, habitat type, behavior (flying, perched, hovering, soaring, coursing), perch site and distance from centers of human activity (farmyards, residences, commercial establishments, etc.). Habitat categories used were (1) cultivated farmland, (2) sage (cold desert including some greasewood), (3) grassland (including pasture and grass dominated rangeland), (4) riparian (including lakeside woods), (5) orchard, and (6) residential (including urban and commercial areas and the immediate area around farm and ranch houses). Perch

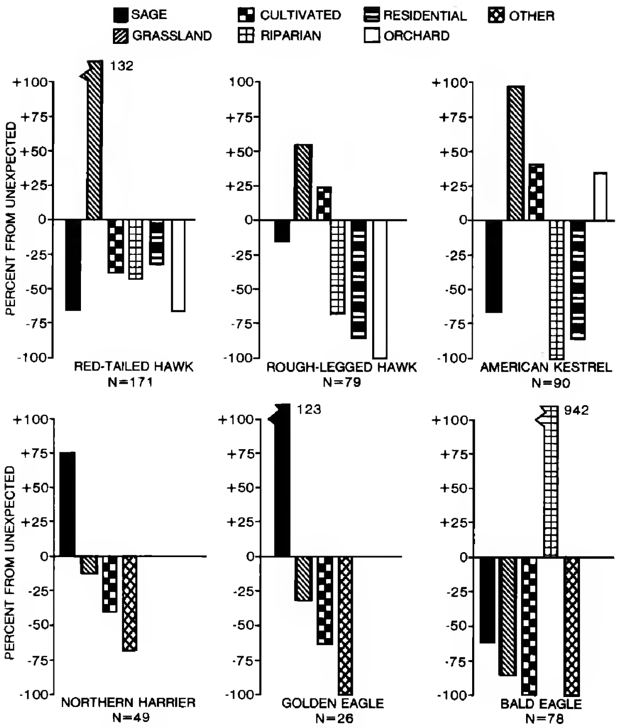

Figure 2. Percent deviation from expected number of raptor sightings by habitat type.

categories were (1) utility pole, (2) fence post, (3) wire, (4) tree, (5) shrub and (6) ground. Distance to human activity was recorded as (1) < 0.16 km, (2) 0.16 to 0.8 km, or (3) > 0.8 km.

Habitat and perch availability were quantified by assuming a census strip width of 1 km (0.5 km each side of road) for that portion of the route on the east side of the lake, and a width of 2 km (1 km each side of road) on the west side of the lake (Fig. 1). These strip widths reflected the maximum lateral distances at which we assumed nearly all raptors present could be spotted with the unaided eye. A random sample of 30, 200-m radius circular plots was taken to estimate the availability of each habitat and perch type within the census strip.

Data were analyzed using non-parametric Chi-square methods in which expected values were calculated from the estimates of relative availability of habitat factors. For example, if 25% of the census strip is cultivated farmland, we expect 25% of the sightings of Red-tailed Hawks to be in this habitat. Categories were lumped when expected values were less than 5 (Cochran 1954).

RESULTS AND DISCUSSION

A total of 525 raptor sightings was recorded on 12 censuses. Most frequently observed species with sample size sufficient to analyze were Red-tailed Hawk (*Buteo jamaicensis*), American Kestrel (*Falco sparverius*), Rough-legged Hawk (*Buteo lagopus*), Bald Eagle (*Haliaeetus leucocephalus*), Northern Harrier (*Circus cyaneus*), and Golden Eagle (*Aquila chrysaetos*). Species observed in smaller numbers were Prairie Falcon (*Falco mexicanus*), Merlin (*Falco columbarius*), Ferruginous Hawk (*Buteo regalis*) and Cooper's Hawk (*Accipiter cooperii*).

Habitat Use - Red-tailed Hawks were not randomly distributed among the 6 habitat types ($P<0.01$). (Fig. 2). The observed number of birds in sage/greasewood desert was approximately a third of that expected, while the number found in grassland habitat was over twice that expected.

Rough-legged Hawks were also not randomly distributed among habitat types ($P<0.1$). They were found at approximately the expected frequency in sage, more often than expected in grasslands and far less often than expected in developed areas (residential, etc.) (Fig. 2). This species breeds in remote, nearly treeless areas of the far north (Brown and Amadon 1968). Consequently it is not surprising that it prefers open habitat and shuns areas of intensive human activity.

Kestrels were also distributed non-randomly among habitat types ($P<0.01$). They were found

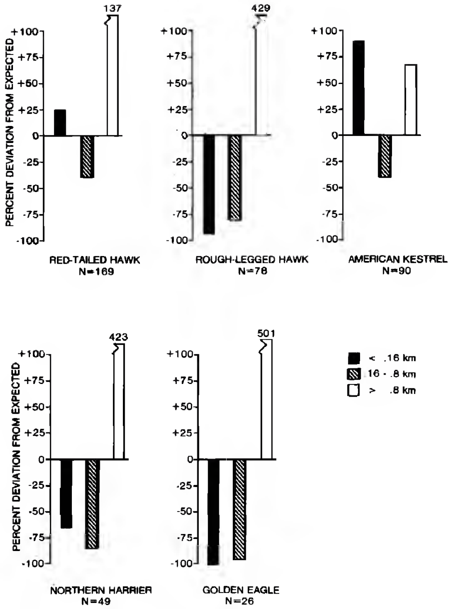

Figure 3. Percent deviation from expected number of raptor sightings by perch type.

twice as often in grassland as expected, but only one-third as often as expected in sagebrush (Fig. 2).

Of 4 habitat categories that could be considered (riparian, residential and orchard habitats lumped due to low expected numbers), Northern Harriers and Golden Eagles occurred more frequently than expected in sagebrush and less frequently than expected in all other habitats (Fig. 2).

Bald Eagles showed the most restricted habitat use pattern (Fig. 2). They were observed almost exclusively along the west shoreline of Utah Lake, and only where open water was nearby. Though the affinity of wintering Bald Eagles for open water is well documented (Fawks 1960; Southern 1963; Steenhof et al. 1980), most wintering Bald Eagles in Utah occur in sagebrush dominated desert valleys and subsist largely on carrion (Edwards 1969; Platt 1976). The narrow habitat choice found in this study is atypical of the normal habitat use pattern of the species in Utah.

Rough-legged Hawks, harriers, kestrels and, to a lesser extent, Red-tailed Hawks are known to prey heavily on cricetine and microtine rodents (Craighead and Craighead 1956). Only Northern Harriers occurred in expected or greater than expected numbers in the sagebrush habitat. The other species used grasslands more often than expected. Though we attempted no investigation of abundance and distribution of prey species, a previous study in central Utah reported similar numbers of rodents in sage-greasewood as in grassland habitat (Woodbury 1955). Thus, it appears the prey base of the grassland habitat supports more species and greater numbers of wintering raptors than does the prey base of the sagebrush desert. This may be due to greater vulnerability of prey to predation by diurnal raptors in grasslands than in the sagebrush. Furthermore, in the desert, where elevated perches are scarce, the aerial foraging of harriers may be more efficient than the perch and hover hunting strategies employed by Rough-legged Hawks and kestrels.

Perch Use - Raptor perches were primarily (83%) in trees or on utility poles. Rough-legged Hawks used poles more than expected ($P < .01$) whereas Red-tailed Hawks used tree and pole perches roughly according to their availability (Fig. 3). Schnell (1968) and Weller (1964) reported that Rough-legged Hawks tend to perch on poles and lone trees, while Red-tailed Hawks tend to select

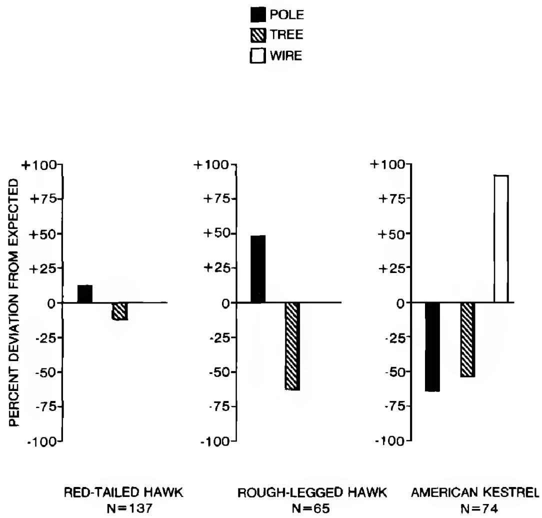

Figure 4. Percent deviation from expected number of raptor sightings by distance from centers of human activity.

perches in groves of trees and along wood edges.

Wires, a frequent (77% of total) perch of kestrels, were crudely quantified as being equal in availability to poles. Although the number of potential perch sites along an interpole length of wire is far greater than on a single pole top (or cross arm), we assume that the choice facing an individual kestrel is essentially a dichotomous one — pole or wire? Kestrels used wire perches more and poles and trees less frequently than expected ($P<.01$, Fig. 3). Bildstein (1978) also reported a preference of kestrels for wire perches.

Sixty-five of 66 perched Bald Eagles were in trees. Too few sightings of perched Golden Eagles and Northern Harriers were recorded to permit a statistical analysis of perch site preference.

Human Disturbance - Red-tailed and Rough-legged Hawks used undeveloped areas more than developed areas ($P<0.01$, Fig. 4). Over twice as many Red-tailed Hawks were seen more than 0.8 km from human disturbance as would have been expected by chance alone. Only 12 of 79 (15%) observations of Rough-legged Hawks were within 0.8 km of human habitation. Interestingly, slightly more Red-tailed Hawks than expected were recorded within 0.16 km of centers of human activity. Large trees were often present around farmyards and ranch houses, whereas trees were often lacking nearby. The greater than expected number of Red-tailed Hawk sightings close to potential human disturbance may be due to a greater availability of perches. Rough-legged Hawks appeared not to use trees as readily as pole perches, and thus, did not perch as often as expected near centers of human activity. Alternatively, Rough-legged Hawks may be less tolerant of human disturbance than are Red-tailed Hawks, and the Rough-legged Hawk's use of poles may be due, at least in part, to the proximity of a large proportion of the study area's trees to human activity.

American Kestrels were distributed non-randomly also ($P<0.01$). Almost twice as many kestrels were seen $<$ 0.16 km from human activity as were expected (Fig. 4). Bildstein (1978) found that kestrels used areas nearer centers of human activity than did other raptors wintering in Ohio.

Northern Harriers, Golden and Bald Eagles were seen almost exclusively in undeveloped areas. Therefore, no statistical analysis of this trend was performed. These species seem to avoid developed habitat.

ACKNOWLEDGMENTS

We thank our wives, Darlene Fischer and Barbara Ellis, who either spent weekends looking for hawks or spent them alone. Chris Ellis and Pam Thompson assisted on the censuses. Michael Kochert and Clayton White provided editorial comments which greatly improved this manuscript.

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Request for Information

Information is being gathered on the post-release behavior and survival of captive-reared and rehabilitated birds and mammals. The objectives of this study are to assess the amount and type of work that has already been done, to summarize the available data and evaluate techniques, and define the reasons for the survival or mortality of released animals.

Published and unpublished reports and raw data would be appreciated. For additional information, individuals willing to cooperate please contact Daniel R. Ludwig, Ph.D., Willowbrook Wildlife Haven, Forest Preserve District of DuPage County, P.O. Box 2339, Glen Ellyn, IL 60138.

Raptor Collisions with Utility Lines — A Call for Information — The U.S. Bureau of Land Management, Sacramento, in cooperation with the Pacific Gas and Electric Company, is assembling all available published and unpublished information concerning collisions of raptors with power lines and other utility lines. Actual case histories — no matter how circumstantial or fragmentary — are needed. Please acknowledge that you have such information by writing to Dr. Richard R. (Butch) Olendorff, U.S. Bureau of Land Management, 2800 Cottage Way, Sacramento, California 95825 U.S.A. (Phone (916) 484-4541). A form on which to record your information will then be sent by return mail.

DO NORTHERN HARRIERS LAY REPLACEMENT CLUTCHES?

ROBERT EDWARD SIMMONS

ABSTRACT - An ecological difference between North American and European populations of *Circus cyaneus* is the apparent lack of replacement clutches laid by the North American form (the Northern Harrier) on the failure of the first clutch. I present several lines of evidence that Northern Harriers do lay replacements, but only if their clutches are disturbed during laying or shortly thereafter. Two of the five females that renested were successful in their attempts and the quality of the new nest sites was higher, despite most renests being within 200 m of the old sites.

In 2 detailed and long term (> 20 y) studies of *Circus cyaneus*, one in Orkney, Scotland (where it is called the Hen Harrier), and one in Wisconsin, U.S.A., a major ecological difference is evident. Harriers in Scotland may lay 1 and occasionally 2 replacement clutches following the failure of their original clutch (Balfour 1957), while harriers in Wisconsin have never been recorded as laying a replacement (Hamerstrom 1969, pers. comm. 1981; Schmutz and Schmutz 1975). Since Simmons and P.E. Barnard (MS) found few behavioural differences in a comparison of the 2 continents' populations, other than migratory habits, then this apparent difference warrants attention and explanation.

Here, I present evidence that harriers in a large Canadian population laid replacement clutches in all 3 y in which they were studied, and that renesting females picked higher quality sites for their second attempts.

STUDY SITE AND METHODS

One of North America's largest assemblages of breeding harriers was studied on the 60 km² Tantramar Marsh (45°53'N, 64°20'W), New Brunswick. The objectives were to document breeding and feeding ecology of the population in relation to polygyny. In so doing, the location of each nest was mapped and its history detailed; the date of settling, habitat type, courtship displays, clutch size, and male and female activity (see Simmons 1983 for details). About 2500 h of observation were made, of which 562 h were specific nest watches to record feeding rates.

As no birds were marked, the evidence presented here consists of the followng categories: (a) recognition of plumage characteristics and voice; (b) identical reaction to human disturbance at both nests, which varied significantly among females; (c) short relaying period; (d) lack of "sky dancing" (Hamerstrom 1969) from any male involved following nest predation; (e) close proximity of nest and renest; and (f) alarm-calling at the nest up to 2 d after nest failure.

To determine nest site quality, I recorded dominant vegetation, moisture level, and visibility at each of 64 nests found. Moisture was ranked as Dry if no water existed within 1 m of the nest, Wet if water appeared due to my weight, and Very Wet if water was already present at the site. Vegetation was ranked as cattail (*Typha* spp.), marsh grasses (*Spartina pectinata* or *Calamagrostis canadensis*), Spirea (*Spirea latifolia* and other low shrubs), and alder (*Alnus* spp. and willow *Salix* spp.). Visibility, which was later found to have no effect on the success or failure of each nest (Simmons and Smith 1985), is disregarded here since it does not affect quality. Quality reflects the probability of success, and the quality score for each nest site is a combination of the percentage success of moisture and vegetation categories arcsine transformed, and summed (see Simmons and Smith 1985).

RESULTS AND DISCUSSION

Suspected renesting occurred twice among 30 nests in 1980, and in 3 of 22 nests in 1981. The original nest of a suspected renest in 1982 was not found, and details of 2 renests in 1983 (R.B. MacWhirter and G.L. Hansen *in litt.*) were not taken, and are not discussed further here.

In the first case in 1980, a yellow-eyed female distinguished by a very dark terminal tail band had just completed a clutch of 5 eggs (determined by egg colour: Sealy 1967; Hamerstrom 1969, pers. obs.) in Cattails. She reacted to me by flying 300-400 m east and circled at low altitude while alarm calling. On my next visit, a bird already 300-400 m east of me started cackling. Later, the same bird flew to the new nest and was recognized by her eye and rectrix colour. The fact that she alarm-called near her new nest on my first visit would have been unusual for any other harrier with no prior experience of my activities. In my experience at 59 other first nests, a female never called until I was closer than approximately 80 m on my first visit.

The second nest-renest evidence in 1980 ("Alders": Table 1) consisted of (a) close circling and calling but no stooping by the female, (b) a 7-d relaying interval, (c) a lack of sky dancing by her polygynous mate who otherwise performed a greater number of displays than any other male (Simmons 1983), and (d) a renest only 160 m from the original site. She was 1 of 2 polygynous females (Table 1) who relaid with the same male (polygynous males were identified by watching them feed one, then another female in succession).

In 1981, in an effort to gain accurate data on egg laying and incubation periods, I disturbed several females with 0- or 1-egg clutches. Five of 6 females

Table 1. Factors associated with 5 renests located on the Tantramar Marsh of New Brunswick, 1980-1981.

	Renesting Factors*						
Nest	I	II	III	IV	V[a]	VI[b]	VII
Midgic 1	8	320	9 May 1980	Just completed clutch	5	144	
Renest			27 May 1980		5	140	S
Alders γ	7	160	18 May 1980	Egg-laying	4	117	
Renest			31 May 1980		4	114	F[c]
Midgic 2	11	100	14 May 1981	First egg	1	92	
Renest			25 May 1981		2	133	S
Alders β	4	120	14 May 1981	First Egg	1	92	
Renest			18 May 1981		5	118	F[d]
Phoebe	7	200	1 June 1981	First egg	1	140	
Renest			8 June 1981		4	140	F[e]

* — I = days between failure and relaying; II = proximity of nests (m); III = clutch initiation dates; IV = stage at failure; V = clutch size; VI = quality score of nest site; VII = outcome of renest attempt: S = successful, F = failed.

[a]All renest clutches were full clutches and hatched.

[b]Based on moisture and vegetation at the nest site (see text); range of scores 92-144.

[c]Diseased chicks

[d]Observer induced

[e]Predation

deserted, and 2 of 5 relaid. A third female, whose 1-egg clutch was taken by a lone Common Raven (*Corvus corax*), also relaid. In each case, a renest was established using 2 or more of the categories outlined in METHODS. One β female continued to defend her destroyed renest for 2 d following its destruction. This is in contrast to evidence presented by Hamerstrom (1969) for Wisconsin harriers which left the area within 24 h of nest loss, and indicates the potential for a female to remain and renest on the Tantramar Marsh.

Three characteristics common to all 5 renesters emerge from their histories: (1) all failed while in the process of egg-laying or shortly thereafter; (2) the distance between the nests was, in 4 of 5 cases, closer than the minimum distance recorded between concurrently occupied nests (260 m); and (3) the period between failure and relaying was short, averaging 7.4 ($\pm$ 3) d. Morrison and Walton (1980), in their review of replacement clutches in raptors, reported that the frequency of relaying was greater among birds whose clutches were disturbed early in the breeding attempt, and that renesting generally took place within "several hundred metres". These facts concur with (1) and (2) in this study. The significance of the short relaying period (3) can be seen in light of the fact that on the Tantramar Marsh, females settling into new territories (i.e. courting and preparing to lay eggs) required at least 1 wk and usually longer (Simmons 1983) to put on sufficient fat/protein reserves (cf. Newton et al. 1983, Hirons et al. 1984) before laying their first egg. Since the *average* relaying interval was only 1 wk for renesters, this implies that a female part way through laying finds it easier to begin a new clutch, having not fully depleted her protein reserves, than a female starting afresh. This may explain the short relaying interval (Table 1). It is also significant in this regard that the female with the longest relaying interval (Midgic 2) also produced the smallest repeat clutch (Table 1), and was fed very little by her monogamous mate (Simmons 1983).

A related but paradoxical fact arises from a comparison of relaying intervals reported for other

small falconiforms (12-18 d : Morrison and Walton 1980) and those found in this study (7.4 d). This difference may be related to the fact that many of the falcons and accipiters cited (*ibid.*) were deliberately double-clutched and therefore "failed" after producing a full clutch, while the harriers failed earlier in their attempts. The relaying intervals (Table 1) concur with those found by Balfour (1957) who stated that replacements were often completed within a fortnight by Hen Harriers in Orkney. The frequency of renesting (8 nests in 96: 8% [Simmons 1983, 1983a; G.L. Hansen and R.B. MacWhirter *in litt.*]) over 4 y on the Tantramar Marsh is also similar to that found in Orkney (N. Picozzi, pers. comm.).

Newton (1979:136) argued that the proportion of relaying raptors in a population is determined by food supply; evidence from this study does not support this hypothesis. Microtines and shrews (*Sorex* spp.), principal prey of the harriers on the Tantramar Marsh (Barnard 1983), were sampled each year (*ibid.* and G.L. Hansen *in litt.*) and related to the proportion of renesters. Spring vole abundance could be ranked from highs in 1980 and 1983 to lows in 1981 and 1982, yet renests accounted for 6.3%, 6.6%, 13.6% and 8.3% of all nests in these years respectively. Several factors (other than my research activities) therefore must have been operating over and above food abundance to produce these results.

Further evidence which does not support the food-related hypothesis comes from a survey of other records of renesting among Northern Harriers. Riendahl (1941) reported 1 nest among 5; Craighead and Craighead (1956) reported 1 renest among 9 in a year of low vole abundance, but none in a "high" year; Smith (1971) recorded 1 among 5 nests, and Duebbert and Lokemoen (1977) reported 1 among 3 nests. If low numbers of nests were indicative of a low vole population (cf. Hamerstrom 1979; Simmons et al. in prep.) in these studies, then none of them support the food-related renesting hypothesis (Newton 1979).

If nests are destroyed by predators, it is surprising that the harriers studied generally renested within 200 m of their original sites; their mates often held territories up to 1 km in diameter (Simmons 1983), and suitable nesting substrate appeared to be relatively unlimited. This unusual situation was investigated through an estimation of the quality of the nest and renest in terms of anti-predator adaptations. This was based on the knowledge that Very Wet cattail sites were significantly more successful than most other combinations (Simmons and Smith 1985). The results indicate that harriers could afford to locate their renests close to their original nests, since on average they chose better quality sites. Four of the 5 renests stayed in high quality sites or increased in quality, while overall the quality scores increased by an average of 12 points; this was not significant, however (Wilcoxson test, U = 10, P = 0.3). Even so, all 5 renesters hatched eggs; 2 raised flying young and only 1 renest failed again due to predation.

I conclude that North American harriers do lay replacement clutches if their original clutch fails early in the attempt, at about the same frequency as their European conspecifics. As the Northern Harrier is behaviourally very similar to the Hen Harrier, the fact that they both lay replacement clutches adds to the contention that they are also ecologically very similar.

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UNUSUAL PREDATORY AND CACHING BEHAVIOR OF AMERICAN KESTRELS IN CENTRAL MISSOURI

BRIAN TOLAND

ABSTRACT - Caching behavior of the American Kestrel (*Falco sparverius*) was studied 1981-1983 in Boone County, Missouri. Both wild prey and quarry thrown from car windows were cached. Kestrels cached food 116 times and retrieved it 77.5% of the time. Males cached food in elevated sites (at least 4 m high) 64% of the time while females did so only 20%. During spring and summer, 93% of the prey items were cached uneaten. During fall and winter, only 42% of the food cached was uneaten. When a surplus of prey was created by releasing several mice at a time, kestrels killed them while flying to their cache sites. These prey items were stored in the same cache site. Apparently, caching behavior of American Kestrels is not directly correlated with the length of time between feedings, and caching behavior operates independently of food deprivation, especially in spring and summer.

Many reptors have been observed caching prey. Mueller (1974) provided a review of food storing in several captive species. Among the falconiforms, prey caching seems to be most developed and widespread in falcons. Published records of caching include those for the Merlin (*Falco columbarius*) (Greaves 1968; Oliphant and Thompson 1976; Pitcher et al. 1982), American Kestrel (*F. sparverius*) (Pierce 1937; Tordoff 1955; Roest 1957; Stendell and Waian 1968; Balgooyen 1976; Collopy 1977), Prairie Falcon (*F. mexicanus*) (Peterson and Sitter 1975; Oliphant and Thompson 1976), Peregrine Falcon (*F. peregrinus*) (Beebe 1960; Brown and Amadon 1968; Nelson 1970; Cade 1982), Gryfalcon (*F. rusticolus*) (Jenkins 1978; Cade 1982) and many others.

STUDY AREA AND METHODS

Data reported here are from a 48 km² area in Boone County, Missouri, where farmlands are interspersed with woodlots, old fields, meadows and residential areas.

I observed kestrels from September 1981 through August 1983 using a 30x spotting scope and 9x binoculars at distances of 5-200 m. For each observation I recorded species cached, location of cache, weather conditions, time of day, and duration of caching sequence. Additional live prey was thrown from my car window to kestrels perched within 25 m of roads. The prey thrown were brown, gray, white and black House Mouse (*Mus musculus*) and House Sparrows (*Passer domesticus*) with several primaries pulled to ensure their capture by kestrels.

RESULTS AND DISCUSSION

During the 2 yr study 1210 h of observation of kestrels were made and 30 kestrels were seen caching prey a total of 116 times. They subsequently retrieved food successfully 77.5% of the time. Prey cached were 95% rodents and 5% birds. Both wild and provided prey were cached. Kestrels captured 95% of the prey thrown from car windows and cached 46 (48%). The remaining 70 (60%) prey cached consisted of 55 Prairie Vole (*Microtus ochrogaster*), 6 house mice, 3 White-footed Mouse (*Peromyscus leucopus*) 2 Western Harvest Mouse (*Reithrodontomys megalotis*), 2 House Sparrows, 1 Grasshopper Sparrow (*Ammodramus savannarum*) and 1 Eastern Meadowlark (*Sturnella magna*).

Cache sites were of 8 kinds (Table 1). Males cached prey in elevated sites significantly more

Table 1. Cache sites used by American Kestrels in Boone County, Missouri 1981-83.

	LOCATION AND HEIGHT OF CACHES								
Sex	Grass clumps (0-0.1 m)	Hollow railroad ties (0-0.1 m)	Tree roots (0-0.1 m)	Bushes (0.5-1.0 m)	Fence posts (1.0 m)	Building gutters (4.0 m)	Tree limbs and holes (4.5 m)	Tops of power poles (10.0-20.0 m)	Total
M	16	3	1	1	6	2	44	3	76
F	27	0	0	2	3	0	8	0	40

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often than did females (Table 1). Males cached prey 4 m or more above the ground 64% of the time, while females did so only 20% ($X^2 = 22.16$, $P<0.01$, df = 1).

During the breeding season kestrels have special courtship feeding ceremonies (Fox 1979; Cade 1982). Food transfer often begins as remote food passing (Nelson 1977) when the male deliberately caches prey within view of the female. When he leaves, she flies to the cache, retrieves and eats the food. I observed that all copulation and courtship activities including hitched wing-displays, food begging, courtship feeding and remote food passing occurred at elevated sites, on or near favorite plucking or hunting perches. Because males alone cache prey at these elevated sites during courtship they may be predisposed to cache in elevated sites during the rest of the year.

Partially eaten carcasses were always decapitated before being cached and only the posterior 2/3 to 1/2 of the body of the prey was placed in the cache. However, kestrels cached 78% (36 of 46) of the presented prey and 69% (48 of 70) of wild prey completely uneaten. Of all prey items cached, only28% (32 of 116) were decapitated. In contrast Stendell and Waian (1968) reported that 14 of 15 small mammals cached by a single female kestrel were decapitated and Collopy (1977) reported that 10 female kestrels decapitated 13 of 17 (76.5%) small animals cached. In Missouri kestrels cached more (58%, 27 of 48) partly-eaten prey during the fall and winter than the 7% (5 of 68) during spring and summer, which may be explained by the lack of hunger during the breeding season due to greater availability of food and warmer temperatures.

Kestrels hiding food approached the cache site furtively, then thrust, pushed, or nudged the prey into position with the beak (see Balgooyen 1976; Collopy 1977). Sometimes sites apparently were selected before the flight started, and kestrels flew directly to the cache spot. Prey was not placed in any preferential position such as belly-down (as if to take advantage of the prey's protective coloration) as reported by Balgooyen (1976) and Collopy (1977). I found items lying on back or sides as often as on the belly. Kestrels sometimes did make several attempts at repositioning prey until it was better concealed. In all cases when prey was stored on the ground in grass clumps, kestrels chose sites next to fence posts, utility poles, sign posts, or other markers. Tordoff (1955) observed that a captive kestrel which cached prey used objects nearby to memorize the location of the cache site.

When retrieving prey, kestrels flew to the cache site and if unable to find stored prey, hovered above the area or walked to adjacent grass clumps to search. In several instances kestrels appeared to give up their search when they flew to a nearby perch, only to return and resume the search. One female kestrel spent 15 min investigating grass clumps both on foot and in brief hovers before giving up.

Because my field observations were evenly distributed throughout the day, I assumed that there was no difference in the probability of observing either prey storing or retrieval (see Collopy 1977). On this assumption, I considered my caching data as a representative sample of the relative frequency of prey caching and retrieving and calculated a recovery efficiency of about 78%, similar to the 70% reported by Collopy (1977).

I observed that presenting kestrels with live prey stimulated a response that simulates the reactions of kestrels to natural prey. The typical response was to fly from the perch toward the prey within 20 sec of its detection. Kestrels then would either (1) bind to the quarry on the ground and kill it with a bite to the neck immediately (or after having flown to a nearby perch) or, (2) snatch the prey from the ground without landing and fly to a nearby perch to dispatch it with a bite to the neck.

On 6 March 1982 at 1430H I observed a female through binoculars from a distance of 100 m. The weather was 38°C, calm and clear. I approached in my car to within 25 m, threw a white mouse out the window and waited. Within 2 min the kestrel approached within 4 m of my car, hovered, and then retreated to a wire 20 m away. I then threw out 2 more mice and backed the car 25 m away. At 1440 H the kestrel again flew toward the mice but after hovering above them and looking at my car, again retreated to the wire only 15 m distance. I then presented 4 more white mice for a total of 7, all of which were conspicuous against a recently mowed lawn. At 1445 H the kestrel flew to a wire only 5 m from the mice and after hesitating for 15 or 20 sec flew down and captured a mouse. However, she immediately flew west 75 m during which flight I saw her bend over several times in midair to bite the neck of the mouse. She immediately landed on the ground and cached the prey in a grass clump at the base of a fence post. She quickly returned to cap-

ture and dispatch in flight the remaining mice in rapid succession. All 7 mice were cached in 1 or 2 grass clumps 1 m apart. None of the 7 mice were eaten at this time.

A month later at the same time of day a male took 7 mice in the same fashion, killing them midair as it flew to the cache site in a white oak tree (*Quercus alba*).

I was able to elicit the capture and caching of as many as 10 mice in sequence by both captive and wild kestrels when presenting them with prey one at a time, over 2 to 8 h periods. Nunn et al. (1976) reported that 1 wild female took 20 white mice thrown from a car window one at a time, over an hour. I found no literature reports of American Kestrels responding to a sudden increase in prey availability by mid-flight killing and caching of successive prey items uneaten.

Caching has been described as a behavorial mechanism to exploit a seasonal or daily abundance of prey, thereby maximizing food intake and dampening the effects of fluctuations in prey availability (Balgooyen 1976; Collopy 1977). My studies agree with other researchers that kestrels, like other falcons, store extra food for periods of a few hours to several days, especially when the capture of sufficient prey may be difficult (i.e., inclement weather, snow cover, or brood rearing).

Although winter food storing in kestrels may be stimulated by a "hunger drive" (see Mueller 1973, 1974) in part, my observations agree with Collopy (1977), Fox (1979) and Cade (1982) that Lorenz' (1937) model of instinctive behavior operating independently of food deprivation occurs in kestrels during the nesting season. Mueller's (1973) laboratory findings, in which the predatory behavior of kestrels was directly correlated with length of time between feedings, was not substantiated. Fifty-eight percent of the prey cached in fall and winter was partially eaten, but only 7% during the nesting season. This indicates that hunger drive does not explain caching behavior of courting males or parental food storing behavior during nesting.

When presented with a surplus of easily captured prey (both in late winter and spring) kestrels killed prey as they flew to a cache site, thus expediting capture of an ephemeral abundance of prey.

The accompanying caching of multiple prey items in the same cache or nearby appears to be yet another example of the flexible behavior of kestrels attempting to hurriedly exploit sudden surpluses in prey availability. Because I saw kestrels caching 7 prey items together in a 5-min period, I cannot support Mueller's (1973) statement that "excessive killing resulted from the falcon "forgetting" that it had cached food when it was exposed to the prey stimulus." Kestrels cache several consecutive prey items in the same spot in a period of minutes or days, and later retrieve them (Stendell and Waian 1968).

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SHORT COMMUNICATIONS

1981 - An Extraordinary Year for Golden Eagle "Triplets" in the Central Rocky Mountains

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The clutch size of the Golden Eagle (*Aquila chrysaetos*) ranges from 1 to 4 eggs with a mean near 2 (Brown 1977). Clutches of 3 are unusual, occurring less than 10% of the time (Table 1). Normally, 1 to 3 young fledge/successful nest with a mean of 1.2 to 1.4 (Brown 1977).

Table 1. Frequency of 3-egg clutches in the Golden Eagle.

STUDY AREA	YEAR(S)	NO. OF CLUTCHES	NO. OF 3-EGG CLUTCHES	% OF 3-EGG CLUTCHES	REFERENCE
California		21	3	14.3	Slevin, *in* Arnell 1971
Scotland		82	8	9.8	Gordon 1955
Colorado		5	0	0.0	Jollie, *in* Arnell 1971
Montana	1963-1964	60	4	6.7	McGahan 1966
Montana	1963-1968	30	1	3.3	Reynolds 1969
Utah	1957-1958	5	0	0.0	Hinman [no date]
Utah	1967-1968	23	1	0.4	Murphy et al. 1969
Utah	1969-1970	26	8	30.8	Arnell 1971
Idaho, Oregon	1966	15	1	6.7	Hickman [no date]
TOTALS		267	26		
MEAN				9.7	

Various factors, from failure to lay eggs to mortality of nestlings, reduce the probability of a pair of eagles fledging 3 ("triplets") from a nest. Table 2 compares data on the frequency of 3 fledgling nests from various studies of Golden Eagles in the western United States.

In 1981, we independently surveyed eagle nests for productivity and recorded nests with 3 nestlings. We subsequently discovered that other investigators, in Utah especially, found 5 nestling nests. The mean percentage (3.8%) of nests fledging triplets in 1981 in Utah, Colorado, and Wyoming is significantly higher $P < 0.10$) than the mean percentage of triplets for other years in the western United States (Table 2). We assumed that mortality of the nearly-grown nestling eagles observed in 1981 was low and that most nearly-grown nestlings fledged. Most studies with which we compared our data also made that assumption by counting nearly-grown nestlings as fledglings.

Many factors can influence productivity in Golden Eagles as reviewed by Newton (1979); also see Edwards and Collopy 1983). We are unable to assess the influence of these factors on the high number of triplets in 1981 with the possible exception of the influence of high prey densities. Clutch size, and therefore, ultimate productivity (number of fledged young/successful nest), are partly influenced by the quantity of food adult females eat before egg-laying affecting her nutritional state of health (Newton 1979). Newton (1979) pointed out that rodent-eating raptors lay clutches that can vary directly in size with rodent densities in the nest area. This allows raptors to exploit rodent and other cyclic prey species in high density years by increasing productivity. Evidence suggest that this is true of Golden Eagle-prey relationships, because the eagle's diet in North America is mainly (74%) lagomorphs and rodents (Olendorff 1976) that exhibit cyclic populations (Murphy 1975). This relationship may be moderated by other factors.

In the western United States lagomorph populations appear to have increased in the years leading up to 1981. In southwestern Idaho populations of Black-tailed Jackrabbits (*Leus californicus*) reached plague proportions in the winter of 1981-82, as reported in the popular press (e.g., Trueblood 1982). Jackrabbit densities were the highest in 9 y in 1981 in the Snake River Canyon of Idaho (Steenhof et al. 1983). In Utah, jackrabbit censuses con-

Table 2. Frequency of three-fledgling (triplet) Golden Eagle nests in the western U.S.

STUDY AREA	YEAR	TOTAL NO. SUCCESSFUL THROUGHOUT STUDY	NO. WITH TRIPLETS	% SUCCESSFUL w/TRIPLETS	REFERENCE
			Years Other Than 1981		
Idaho, Oregon	1966	17	0	-	Hinman, no date
Utah	1957-1958	5	0	-	Hinman, no date
Utah	1967-1968	18	0	-	Camenzind 1968
Utah	1969-1970	19	3	15.8	Arnell 1971
Wyoming, Colo.	1964-1980	882	1	0.1	Den. Wildl. Res. Ctr. data
Wyoming	1979	11	0*	-	Lockhart et al. 1980
Wyoming, Mont.	1975-1978	34	0*	-	Lockhart et al. 1978
Montana	1963-1964	55	3	5.5	McGahan 1966
Montana	1962-1968	22	0	-	Reynolds 1969
Oklahoma	1974-1975	6	0	-	Lish 1965
Texas	1974-1975	5	0	-	Lockhart 1976
TOTALS		1,074	7		
MEAN				0.7	
			1981 Data		
Utah	1981	95	6	6.3	Present study
Colorado	1981	94	3	3.2	Pearson, Grode pers. comm.
Wyoming	1981	46	0	0	Phillips and Beske 1981
TOTALS		235	9		
MEAN				3.8	

*Data gathered by personal communication with the author.

ducted by the Department of the Army (R. LeClerc pers. comm.) showed that densities were high(though decreasing thereafter) in autumn 1980 at 3 northwestern Utah study sites, moderate populations at 3 others, and low at 1 Nevada site. Data from both Steenhof et al. (1983) and the Army show similar high densities in 1971 supporting the hypothesis of a 10 yr jackrabbit population cycle in these areas.

Increased prey availability for nesting eagles is probably an important cause for higher than normal frequency of triplets in the western United States in 1981. The only other instance of a high frequency of triplets is the study of Arnell (1971) in Utah. He noted high lagomorph populations in 1971, 10 yr before the high number of triplets in 1981.

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Food Piracy Between European Kestrel and Short-eared Owl

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I studied a raptor community of the large field plain of Alajoki in Southern Ostrobothnia, western Finland (63° 05'N, 22°55'E), from 1977 through 1982 (see Korpimäki, et al. 1977, 1979). The most numerous raptor on the study area was the Short-eared Owl (*Asio flammeus*) (315 total pairs, 39.4%), followed by European Kestrel (*Falco tinnunculus*) (36.2%), Long-eared Owl (*A. otus*) (20.0%), Northern Harrier (*Circus cyaneus*) (2.5%), Boreal Owl (*Aegolius funereus*) (1.6%) and Sparrow Hawk (*Accipiter nisus*) (0.3%); for addition details see Korpimäki 1984a). Although the 4 most common species comprise the guild of open-terrain hunting birds of prey in the study area (Korpimäki 1978, 1981), inter- and intraspecific food piracy or kleptoparasitism (see Brockmann and Barnard [21979] for additional details on the terms) was observed only once. Consequently this case may be of some interest.

On 16 May 1982 at 2130 H, I saw a Short-eared Owl in the northern part of Alajoki flying over the field at the height of about 120 m and carrying a vole in its talons. The

owl passed a male European Kestrel sitting on the roof of a barn. The kestrel chased the owl and struck it in the back. It attacked 3 times and the owl took shelter in high vegetation near a ditch. The kestrel stopped attacking and returned to the roof of the same barn. The owl waited for a few minutes on the ground and then started to fly and hunt again. When I examined the location where the owl took shelter, I found a whole Common Vole (*Microtus arvalis*), which was still warm, but no owl nest. The nest in this territory was found on 5 June, when the young were just hatching. Consequently the female was incubating in the middle of May, and the owl observed was probably the hunting male. The kestrel does not breed in the vicinity and was apparently not defending a nest.

The proportion of *Microtus* voles (*M. agrestis* and *M. arvalis*) in the diets of raptors was studied in 1977, when it was 95.5% for Long-eared Owl, 97.6% for Short-eared Owl and 87.7% for European Kestrel (Korpimäki et al. 1977). As rodents are central also in the diet of Northern Harrier (in Norway 57%, Hagen 1952), voles are the most important prey item for raptors of Alajoki, although there are also some alernative prey groups available (e.g., shrews, mice, birds, lizards, frogs and insects; Korpimäki 1984b). Consequently, one might expect a keen inter- and intraspecific competition for food among these birds, especially when voles are scarce. Vole populations crashed in 1980-81 and were in the increase phase in 1982 (Korpimäki 1984a), wherefore a lack of food may have been the reason for piratical behaviour of the kestrel. Also, Brockmann and Barnard (1979) pointed out that kleptoparasitism occurs more frequently during years of a food shortage. The hunting Short-eared Owl flies near the ground and locates its prey by hearing and sight. The hunting technique of the owl is adapted to catching of prey animals in the high grass (for example in uncultivated fields) better than that of the kestrel, which flies or hovers high in the air over the field (Korpimäki 1978). The Short-eared Owl is a vole specialist, while the kestrel preys opportunistically on shrews, birds, lizards, frogs and insects when voles are scarce (Korpimäki 1984b). Thus the Short-eared Owl can probably catch voles of lower densities compared with the kestrel, and it may be advantageous for the kestrel to rob food from Short-eared Owl, which is quite a slow flyer.

Food piracy between the European Kestrel and Short-eared Owl is quite rare. I have found only 6 earlier cases described in literature (from Sweden, Mascher 1963, Nilsson 1975 and from Great Britain, Balfour 1973, Reese and Balfour 1973, Boyle 1974, Clegg and Henderson 1974). Dickson (1971) has described also an interaction of Short-eared Owl, European Kestrel and Northern Harrier on same pipit prey. All above mentioned cases were observed from the end of winter to the beginning of summer when vole populations were at their lowest and the competition for food may have been keenest. Food shortage enhances kleptoparasitism among birds, especially in falconiforms and charadriiforms (Brockmann and Barnard 1979).

Food piracy is more general between open-country predators in central and western Europe than in my northern study area, because harriers can also take prey from Short-eared Owls (11 cases in Great Britain, Watson 1977 and in the United States, Berger 1958, Clark 1975). On the other hand, Short-eared Owl may sometimes adopt piratical behaviour. Wood (1976) has observed that the owl tried to take a small rodent from a Stoat (*Mustela erminea*); Bildstein and Ashby (1975) saw the owl robbing prey from Northern Harrier and Gordon Riddell (according to Mikkola 1983) described a Short-eared Owl attempting to take prey from a kestrel. This apparent difference in frequency of piratical behaviour between regions may be due to the cyclic fluctuations of the vole populations in northern Europe causing a higher degree of nomadism among raptors compared with a more stable food production in more southern areas where raptors tend to be resident. Most raptors migrate from my study area when voles are scarce (Korpimäki 1984a), and this behaviour decreases the competition for food.

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An Unusual Observation of 'Homing' To Prey By A Migrating Immature Peregrine Falcon

CARL SAFINA

On 6 October 1981 at 10:05 EST, while operating a raptor banding station on the Long Island, New York barrier beach, I saw a hatching year female Peregrine Falcon (*Falco peregrinus*) land approximately 50 m from my blind and begin eating a small passerine (probably a White-throated Sparrow (*Zonotrichia albicollis*, based on feathers). The falcon was on a low, beach heather (*Hudsonia*) covered rise in a broad, open rolling area. Soon after the falcon began eating, an Osprey (*Pandion haliaetus*), carrying a fish, came over the falcon, vocalizing. The Peregrine flew up and chased the Osprey over the bay to the north, stooping repeatedly at it before flying out of sight. Within 5 min the falcon reappeared on its kill. As the prey was small, cryptically colored, and in a broad, non-descript area of the beach, and since the Peregrine was not seen searching for it, apparently the falcon remembered exactly where it had left its kill and was able to return there from a point out of sight.

Falcons frequently return to cached prey. What is interesting about this incident is that the falcon was a first year migrant and the topography was almost certainly not familiar (the banding station had been manned daily for 3 w prior, and no Peregrines appeared to have been staying in the area). Enderson (Auk. 81:332-352, 1964) described wintering Prairie Falcons (*Falco mexicanus*) leaving their prey on the ground and driving off other rapors in a similar manner. His falcons seldom had difficulty relocating the prey, but this is not surprising because they were familiar with the area.

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Errata - *Raptor Research* 18(2)

Page 44 (Table 1 concluded), 0.420[g] should appear in the column for shell thickness, 0.49[h] should appear in the column for HE and 0.27[h] should appear in the column for DDE; page 47, paragraph 3, line 6, > 8 ppm should appear as $\geq$8 ppm; page 61, Literature Cited, the Sawby et al. reference appeared in *Condor* 76:479-481; page 70, photographs are reversed.

"The Peregrine Falcon At Reelfoot Lake"

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A tree-nesting "Duck Hawk" populated the Mississippi and Ohio River areas in times past. A remnant nesting population was first documented during the 1930's at Tennessee's Reelfoot Lake by the late Albert F. Ganier. During the 1940's a new nest site was discovered on the west side of the lake by Dr. Walter R. Spofford, then Professor of Anatomy at Vanderbilt University. Dr. Spofford and a few carefully selected observers made yearly nesting observations until the early 1950's.

Mr. Thomas S. Butler was privileged to have been among those who spent many days recording the events of each year's breeding season beneath the enormous cypress tree that served as the falcons' nest site. During the late 1970's a happy circumstance led Tom to meet Murrell Butler, a distant cousin from Louisiana. Murrell was an accomplished wildlife artist and became enthralled by the tales of a Peregrine Falcon that once nested in the snag of the mammoth cypress tree. A subsequent trip to the nest site (the cypress still stands!), the relocation of old photographs and consultation with friends and fellow falconers culminated in this magnificent painting by Murrell Butler.

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